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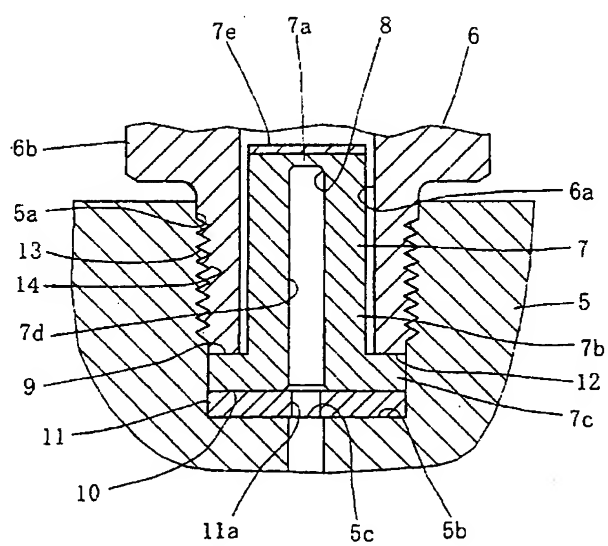
(54) Pressure sensor mounting

(57) A pressure sensor comprising a joint member (6) for securing a pressure sensor body to a fluid channel wall (5) for fluid; and a pressure-detecting element (7) mounted on the joint member (6). The pressure-detecting element is separately formed from the joint member. The pressure-detecting element (7) has a pressure sealing surface (10). The joint member (6) is provided with a sealing force application device (13, 14) for applying a sealing force between the pressure sealing surface (10) and the fluid channel wall (5).

FIG. 1



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D scription

[0001] The present invention relates to a pressure sensor having a structure, which is adapted to detection of extra-high pressure of for example 200 MPa or more such as fuel pressure in a fuel injection apparatus of a vehicle.

[0002] Measure of fluid pressure utilizes a pressure sensor, which detects a pressure difference between pressure to be detected and an atmospheric pressure to convert the same into an electric signal, as disclosed in Japanese Laid-Open Patent Application No. H01-96523 and Japanese Laid-Open Patent Application No. H01-296130. As shown in FIGS. 9 and 10, the conventional pressure sensor has a joint member 2 and a pressure-detecting element 3. The joint member 2 has a fitting means such as a screw portion, a flange portion or the like for securing a pressure sensor body to a fluid channel wall 1 for a fluid, and a sealing means such as an O-ring groove, a tapered face, a sealing surface or the like for providing an pressure-tight condition between the pressure sensor body and the fluid channel. The pressure-detecting element 3 has a pressure diaphragm 3a and a strain gage 3b provided on the pressure diaphragm 3a. An output device (not shown), which is electrically connected to the strain gage 3b, is provided above the pressure-detecting element 3. Pressure of the fluid introduced into a pressure introduction hole 2a of the joint member 2 causes the pressure diaphragm 3a to strain. The strain gage 3b detects the strain of the pressure diaphragm 3a with the result that the output device outputs an electric signal corresponding to value of resistance of the strain gage 3b.

[0003] In case where the pressure range to be detected is increased for example to 200 MPa or more, it is necessary to increase the mechanical strength of the portion of the pressure sensor accordingly, to which pressure is applied.

[0004] In the pressure sensor as shown for example in FIG. 9, the joint member 2 and the pressure-detecting element 3 are connected to each other by welding. Improvement in mechanical strength of the welded portion 4 requires for example an enlargement of the connected area. However, increase in penetration depth to provide a sufficient connected area leads to the increased heat input through the welding. The increased heat input may damage the thin-film type strain gage 3b. It is therefore impossible to adopt such a measure to enlarge the connected area. In addition, deposited metal caused by the welding and the adjacent heat-affected zone may more easily be subjected to an intergranular corrosion and stress corrosion in comparison with the non-heat-affected zone, aggravating corrosion due to contact with the fluid, thus leading to deterioration of sensing properties.

[0005] It is also conceivable to adhere a semiconductor chip serving as a strain gage substituting the thin-film type strain gage 3b on the upper surface of the metallic diaphragm 3a, in order to avoid the damage to the thin-film type strain gage 3b due to the welding. It is however hard to make the thickness of an adhesive layer uniform, thus leading to irregularity of the sensing properties. There may occur problems of an output drift caused by slip of the adhesive layer and deformation thereof after a lapse of time. Existence of the adhesive layer between the diaphragm 3a and the semiconductor chip serving as the strain gage 3b may cause a transfer lag of strain, resulting in delay of an output response speed. In addition, it is hard to place the semiconductor chip on the most suitable position of the metallic diaphragm 3a, leading to irregularity of properties (for example, an output span) and inconvenience in a subsequent step for making an electrical connection (for example, a wire bonding) to the output device.

[0006] The other conventional pressure sensor as shown in FIG. 10 has a joint member 2 and a pressure-detecting element 3, which are integrally formed with each other, thus avoiding the above-mentioned problem of decreased mechanical strength caused by welding. However, a small-diameter deep hole with one end closed has to be formed as the pressure introduction hole 2a, providing a problematic matter. Metal having an excellent mechanical strength and an excellent spring property (for example, precipitation hardened stainless steel SUS 630) is usually used for forming the pressure-detecting element 3. Such kind of steel generally has a low cutting workability, making it difficult to form an appropriate shape in a precise and highly effective manner. In addition, the portion defining the closed end of the pressure introduction hole 2a is formed as the diaphragm 3a. Precision of formation of the diaphragm 3a has an influence on accuracy property, durability and the like of the pressure sensor. Moreover, wear of the cutting tool causes remarkable deterioration of the above-mentioned precision of formation.

[0007] With respect to an apparatus for forming a thin film on the diaphragm 3a, there is required a step for evacuating a chamber. It is therefore reasonable to make the capacity of the chamber as smaller as possible. Further, it is preferable to place workpieces in a number as large as possible in the chamber, in order to manufacture the increased number of pressure sensor through a single step for forming the thin film. Reduce in the capacity of the chamber is restricted by the integral structure of the joint member 2 with the pressure-detecting element 3. As a result, the number of workpieces to be placed into the chamber is limited accordingly, thus leading to a lower manufacturing efficiency in the forming step of the thin-film type strain gage 3b.

[0008] In addition, demands relative to the joint member 2 depend on its purposes and a user with the result that a number of modifications of the joint member 2 are required to satisfy all the demands, leading to restriction in the manufacturing equipment and difficulty in manufacture of all the joint members modified.

[0009] An object of the present invention is therefore to provide a pressure sensor, which is adapted to detec-

tion of extra-high pressure. In such a sensor, it is possible to prevent fluid from coming into contact with a connected area of a joint member and a pressure-detecting element that are separated formed from each other, ensure a condition that, even when welding is applied to the connecting portion between the joint member and the pressure-detecting element, welding heat does not exert adverse influence on a thin-film type strain gage of the pressure-detecting element, avoid the contact of the welded portion with the fluid and provide an easy mounting operation of the joint member, which is suitable for purposes and demands of a user.

[0010] In order to attain the aforementioned object, the pressure sensor of the present invention comprises:

> a joint member (6) for securing a pressure sensor body to a fluid channel wall (5) for fluid; and
> a pressure-detecting element (7) mounted on the joint member (6), said pressure-detecting element being separately formed from said joint member,

characterized in that:

> said pressure-detecting element (7) has a pressure sealing surface (10); and
> said joint member (6) is provided with a sealing force application device (13, 14) for applying a sealing force between said pressure sealing surface (10) and said fluid channel wall (5).

[0011] There may be adopted a structure that said pressure-detecting element (7) has a pressure detection portion, said pressure detection portion comprising a thin-film type strain gage (7e), which is provided on a metallic diaphragm (7a) of the pressure-detecting element (7) through an insulating film.

[0012] Said joint member (6) and said pressure-detecting element (7) may be connected with each other so as to permit a relative movement to each other.

[0013] Said joint member (6) and said pressure-detecting element (7) may be fixed to each other.

[0014] Said pressure-detecting element (7) may have at least one part, which is formed through a forging method.

FIG. 1 is a vertical cross-sectional view illustrating essential portions of a pressure sensor of the first embodiment of the present invention;

FIG. 2 is a vertical cross-sectional view illustrating a state in which the pressure sensor is sealed by a metallic conical packing;

FIG. 3 is a vertical cross-sectional view illustrating a state in which the pressure sensor is sealed by a metallic lens-shaped packing;

FIG. 4 is a vertical cross-sectional view illustrating a state in which the pressure sensor is sealed by a metallic lens-shaped packing having the different shape from that as shown in FIG. 3;

FIG. 5 is a vertical cross-sectional view illustrating a state in which the pressure sensor is sealed by a metallic O-shaped ring or a metallic C-shaped ring;

FIG. 6 is a vertical cross-sectional view illustrating a state in which the pressure sensor is sealed by a ring-shaped projection, which is integrally formed with the pressure-detecting element;

FIG. 7 is a vertical cross-sectional view illustrating the pressure sensor of the second embodiment of the present invention;

FIG. 8 is a vertical cross-sectional view illustrating the pressure sensor of the third embodiment of the present invention;

FIG. 9 is a vertical cross-sectional view illustrating one example of the conventional pressure sensor; and

FIG. 10 is a vertical cross-sectional view illustrating the other example of the conventional pressure sensor.

[0015] Now, embodiments of a pressure sensor of the present invention will be described in detail below with reference to the accompanying drawings.

<FIRST EMBODIMENT>

[0016] A pressure sensor is used to detect extra-high pressure (for example 200 MPa or more) such as fuel pressure in a fuel injection apparatus of a vehicle engine. As shown in FIG. 1, the pressure sensor has a joint member 6 for securing a pressure sensor body to a fluid channel wall 5 for fluid; and a pressure-detecting element 7 mounted on the joint member 6. The pressure-detecting element 7 is separately formed from the joint member 6.

[0017] The fluid channel wall 5 for the fluid is for example a wall of a chamber of the fuel injection apparatus. The pressure sensor is secured through the joint member 6 onto the fluid channel wall 5 serving for example as the wall of the above-mentioned chamber. The fluid channel wall 5 has a recess portion 5a formed therein, to which the pressure sensor is connected. The recess portion 5a is provided on its bottom with a connection face 5b with which an opening end 5c of the fluid channel communicates.

[0018] The pressure-detecting element 7 and the joint member 6 are separately formed from each other, permitting to unification of a shape of pressure-detecting element 7, irrespective of the entire configuration. As a

result, an effective manufacture can be achieved with the use of independent manufacturing equipment. It is therefore possible to cope with many applications relative to the joint member 6, taking into consideration purposes of the pressure sensor and demands of a user. The number of materials to be selected to form the joint member 6 increases. It is therefore possible to select a suitable material, which is inexpensive and excellent in workability, while ensuring a sufficient strength.

[0019] The pressure-detecting element 7 has a diaphragm 7a, a tubular support base 7b for supporting the diaphragm 7a, a seat plate 7c provided on the opposite end of the support base 7b to the diaphragm 7a so as to be formed into a shape of flange, and a pressure introduction hole 7d extending from the lower surface of the seat plate 7c to the inner surface of the diaphragm 7a. These parts are formed by the conventional forging method disclosed for example in Japanese Laid-Open Patent Application No. H10-46239. In order to prepare the pressure-detecting element 7 on the basis of the above-mentioned forging method, the forging is applied to material of precipitation-hardened stainless steel to form the pressure introduction hole 7d and the inner surface of the diaphragm 7a. A turning is carried out to cut the material so as to form the outer surface of the diaphragm 7a, the outer surface of the support base 7b as well as the seat plate 7c. When the pressure sensor is to be used under extra-high pressure (for example 200 MPa or more), it is preferable to adopt a surface configuration having a small unevenness and roughness on inner surfaces of the diaphragm 7a and the support base 7b of the pressure-detecting element 7, to which pressure is applied, in order to avoid stress concentration. The application of the forging to the material of precipitation-hardened stainless steel can provide an appropriate unevenness and roughness of the above-mentioned inner surfaces in comparison with the cutting work. It is also possible to form more effectively a boundary portion between the diaphragm 7a and the support base 7b into a round shape with a higher accuracy in comparison with the cutting work. The surface of the diaphragm 7a to which pressure is to be applied may be subjected to a finishing treatment such as a polishing or the like to improve the unevenness and roughness of the above-mentioned surface, for the purpose of improving reliability of the pressure sensor to be used under the extra high pressure. It is preferable to increase the radius of the boundary portion having the round-shape between the diaphragm 7a and the support base 7b within a prescribed range so long as detection of strain can be made through the thin-film type strain gage 7e existing on the diaphragm 7a.

[0020] The diaphragm 7a serves as a strain-generation portion of the pressure sensor and closes the one end of the pressure introduction hole 7d. The above-mentioned material of precipitation-hardened stainless steel (for example, SUS630) imparts an appropriate mechanical strength and an appropriate spring property to the diaphragm 7a. Application of pressure of the fluid flowing into the pressure introduction hole 7d of the pressure-detecting element 7 to the inner surface of the diaphragm 7a causes the diaphragm 7a to be deformed elastically.

[0021] The thin-film type strain gage 7e is provided through the insulating film (not shown) on the outer surface of the diaphragm 7a, which is opposite to the above-mentioned inner surface to which the pressure is applied. The insulating film is formed of silicon oxide (SiO_2) into a thin film. The thin-film type strain gage 7e is composed of a silicon film, which is formed on the above-mentioned insulating film in accordance with a method for manufacturing a silicon film piezoresistance element, which is disclosed in Japanese Laid-Open Patent Application No. H6-70969. Deposition formation of the silicon oxide film and the silicon film can be achieved by the conventional plasma CVD method. The thin-film type strain gage 7e can be obtained by applying a photo-etching process to the above-mentioned silicon film. Elastic deformation of the diaphragm 7a caused by the pressure of the fluid causes the thin-film type strain gage 7e to be also deformed elastically, thus generating an electric signal corresponding to an amount of deformation. No material such as adhesive exists between the strain gage 7e and the metallic surface of the diaphragm 7a, thus causing no delay in transmission of strain and improving an output response speed. The strain gage 7e is located on the diaphragm 7a in place, thus causing no irregularity of properties (for example, an output span) and permitting to electrical connection to the output device (see FIGS. 7 and 8).

[0022] The upper surface of the seat plate 7c, i.e., the surface thereof locating on the diaphragm 7a side serves as a seating face 9 with which the joint member 6 comes into contact. The lower surface of the seat plate 7c, i.e., the surface thereof locating on the opposite side to the diaphragm 7a serves as a smooth pressure sealing surface 10. A metallic flat packing 11 exists between the pressure sealing surface 10 and the smooth connection face 5b of the fluid channel wall 5 to prevent the fluid from leaking between the pressure-detecting element 7 and the fluid channel wall 5. The flat packing 11 has a through-hole 11a for causing the fluid to flow from the fluid channel wall 5 into the pressure introduction hole 7d.

[0023] The joint member 6 is formed into a tubular body in which the pressure-detecting element 7 is received. The joint member 6 is provided at its bottom facing the above-mentioned seat plate 7c with a smooth contacting face 12 with which the seating face 9 of the seat plate 7c comes into contact. The diaphragm 7a and the support base 7b of the pressure-detecting element 7 are inserted into an insertion hole 6a formed in the joint member 6 along the axial direction thereof so that the seating face 9 of the seat plate 7c comes into contact with the contacting face 12 of the joint member 6. The joint member 6 has on its upper portion a hexagonal por-

tion 6b with which a tool such as a spanner is to be engaged. A sealing force application device for applying a sealing force to the above-mentioned pressure sealing surface 10 is provided on an intermediate portion between the hexagonal portion 6b and the contacting face 12 of the joint member 6. The sealing force application device is composed as a screw connection system. More specifically, a male screw portion 13 is formed on the joint member 6 and a female screw portion 14 is formed on the fluid channel wall 5. A turning operation of the joint member 6 is carried out above the fluid channel wall 5 with the use of the tool engaging with the hexagonal portion 6b, thus ensuring a fastened state of the joint member 6. Thrust applied in the axial direction of the hexagonal portion 6b by screwing the joint member 6 into the fluid channel wall 5 causes the contacting face 12 provided at the lower end of the joint member 6 to come into close contact with the seating face 9 of the pressure-detecting element 7 and further causes the pressure sealing surface 10 of the seat plate 7c, which is opposite to the seating face 9, to press the packing 11 serving as the sealing member against the connection face 5b of the fluid channel wall 5. As a result, the packing 11 is compressed between the pressure sealing surface 10 and the connection face 5b so as to come into close contact with them. With respect to material for forming the sealing member such as the packing 11 or the like, it is preferable to use mild steel or stainless steel in case where the pressure sensor is to be used under pressure of for example 200 Mpa or more. According to the above-described structure, it is possible to ensure a pressure-tight condition at the connection portion between the pressure-detecting element 7 and the opening end 5c of the fluid channel wall 5, thus permitting flow of a high-pressure fluid into the pressure introduction hole 7d in a proper manner without coming toward the connection portion between the joint member 6 and the pressure-detecting element 7.

[0024] In addition, there is provided above the hexagonal portion 6b of the joint member 6 a mechanism for holding the output device (see FIGS. 7 and 8) for outputting an electric signal.

[0025] The sealing force application device, which is composed of the male screw portion 13 and the female screw portion 14 and used in combination with the hexagonal portion 6b, may be substituted by a combination of a flange and a recess into which the flange is fitted.

[0026] The seating face 9 of the pressure-detecting element 7 may be secured to the contacting face 12 of the joint member 6 by welding or the other fixing method. According to such a structure of the pressure sensor, pressure of the fluid is not applied to the welding portion of the seating face 9 with the contacting face 12, resulting in no occurrence of tensile stress in the welding portion. In addition, the welding portion does not come into contact with the fluid. Accordingly, there is no need to consider improvement in mechanical strength of the welding portion and the problem of degradation of performance due to corrosion can be avoided.

[0027] With respect to the sealing method in the above-described pressure sealing surface 10, it is preferable to adopt a metallic sealing structure in which the metallic portions come into contact with each other, in the light of the use under the extra-high pressure. There may be used as such a sealing method, in addition to the metallic flat packing 11 as shown in FIG. 1, a metallic conical packing 15 as shown in FIG. 2, a metallic lens-shaped packing 16 (i.e., a packing having on the upper and lower ends of the lens-shaped member with sealing surfaces, respectively) as shown in FIG. 3, the other metallic lens-shaped packing 17 (i.e., a packing having opposite recess portions with tapers, which serve as the sealing surfaces) as shown in FIG. 4, a metallic O-shaped ring as shown in FIG. 5 or a metallic C-shaped ring. It may also be adopted a direct sealing method in which a ring-shaped projection, which is formed on the pressure sealing surface 10 of the seat plate 7c, is pressed against the connection face 5b of the fluid channel wall 5 so as to provide the sealing structure, as shown in FIG. 6.

<SECOND EMBODIMENT>

[0028] In the second embodiment of the pressure sensor as shown in FIG. 7, the joint member 6 is connected to the pressure-detecting element 7 so as to permit a relative movement to each other. More specifically, the joint member 6 is rotatable around the tubular support base 7b of the pressure-detecting element 7 and slidable along the tubular support base 7b.

[0029] The support base 7b of the pressure-detecting element 7 is inserted into a tubular case 20 and fixed thereto by welding. The tubular case 20 is prepared by applying working such as a press-forming, a cutting and bending process or the like to a metallic sheet formed for example of SUS430. The tubular case 20 stands to extend upward from the diaphragm 7a of the pressure-detecting element 7.

[0030] The tubular case 20 is fitted into the joint member 6, which is formed of steel for general structural purpose and subjected to a plating process (for example, an electroless nickel plating process or a galvanizing process). The support base 7b is fitted into the joint member 6 before carrying out the fitting operation of the tubular case 20. In case where the tubular case 20 has the different shape and structure, the support base 7b may be fitted into the joint member 6 after carrying out the fitting operation of the tubular case 20. There is provided between the outer periphery of the tubular case 20 and the inner periphery of the insertion hole 6a of the joint member 6 with an extremely small clearance by which the joint member 6 is rotatable and slidable relative to the support base 7b.

[0031] There is provided above the diaphragm 7a locating in the tubular case 20 an output device for outputting a fluid pressure in the form of an electric signal.

More specifically, an electric circuit board 21 including an amplification circuit and the like is stationarily held above and near the diaphragm 7a in the tubular case 20, a connector 22 is stationarily held above the electric circuit board 21 and the circuit board 21 and the connector 22 are electrically connected to each other by a flexible board 23.

[0032] The electric circuit board 21, which comprises a laminate-ceramic board, a glass-epoxy board or the like, is secured to the tubular case 20 by adhesive or the other fixing means. The electric circuit board 21 and the flexible board 23 are electrically connected to the thin-film type strain gage 7e by means of bonding wires 24.

[0033] The connector, which is formed of resin material such as PBT (polybutylene-terephthalate) resin, ABS (acrylonitrile-butadien-styrene) resin, PPS (polyphenylene-sulfide) resin or the like, is secured to the tubular case 20 by crimping or the other fixing means. An O-ring 25 for sealing the tubular case 20 is provided in the crimped portion. The electric circuit board 21 is electrically connected to the connector 22 by the flexible board 23.

[0034] The pressure sensor having the above-described structure can be fixed to the fluid channel wall 5 by urging the pressure sealing surface 10 of the seat plate 7c of the pressure-detecting element 7 against the connection face 5b of the fluid channel wall 5 to hold the pressure-detecting element 7 on the fluid channel wall 5 and turning the joint member 6. Turn of the joint member 6 causes the male screw portion 13 to engage with the female screw portion 14, thus generating thrust in the axial direction of the joint member 6. Such thrust causes the contacting face 12 provided at the lower end of the joint member 6 to come into close contact with the seating face 9 of the pressure-detecting element 7 and further causes the pressure sealing surface 10 of the seat plate 7c, which is opposite to the seating face 9, to press the packing 11 serving as the sealing member against the connection face 5b of the fluid channel wall 5. As a result, the packing 11 is compressed between the pressure sealing surface 10 and the connection face 5b so as to come into close contact with them. The portion ranging from the pressure-detecting element 7 to the connector 22 can be kept static relative to the fluid channel wall 5 during a fastening operation of the joint member 6, thus making it possible to determine accurately the posture and position of the connector 22 on the fluid channel wall 5.

<THIRD EMBODIMENT>

[0035] In the third embodiment of the present invention, the joint member 6 is fixed to the pressure-detecting element 7 as shown in FIG. 8, unlike the pressure sensor of the second embodiment of the present invention. More specifically, the seating face 9 of the seat plate 7c of the pressure-detecting element 7 abuts against the contacting face 12 of the joint member 6, which is formed of for example SUS304, SUS430 or the like to which welding can be applied. The seating face 9 and the contacting face 12 are connected to each other by welding (for example, a laser welding).

[0036] In such a structure, the pressure sealing surface 10 is provided on the lower surface of the seat plate 7c of the pressure-detecting element 7 and the pressure sealing surface 10 is urged against the connection face 5b of the fluid channel wall 5 through the packing 11. Accordingly, pressure of the fluid is not applied to the welding portion 26, resulting in no occurrence of tensile stress in the welding portion 26. In addition, the welding portion 26 does not come into contact with the fluid. Accordingly, only consideration of mechanical strength of the welding portion during the fastening operation of the joint member 6 suffices. Further, there is no need to ensure pressure-tight connection at the welding portion 26.

[0037] The connector 22 of the pressure sensor is fixed to the joint member 6 by applying a crimping method to a thin portion at the upper end of the joint member 6 so as to enclose the sealing O-shaped ring 25.

[0038] According to the present invention as described in detail, it is possible to prevent fluid from coming into contact with the connected area of the joint member and the pressure-detecting element of the pressure sensor, ensure a condition that, even when welding is applied to the connecting portion between the joint member and the pressure-detecting element, welding heat does not exert adverse influence on the thin-film type strain gage of the pressure-detecting element, and avoid the contact of the welded portion with the fluid. It therefore becomes possible to detect extra-high pressure of for example 200 MPa or more. In addition, it is possible to provide an easy mounting operation of the joint member, which is suitable for purposes and demands of a user, thus permitting to manufacture of the joint member in correspondence to a number of modifications of the joint member. Further, the pressure-detecting element is separately formed from the joint member, with the result that only the pressure-detecting elements can be placed in the vacuum chamber of an apparatus for forming a thin film on the diaphragm. Accordingly, the single step for forming the thin film leads to manufacture of a plurality of pressure sensors, thus improving manufacturing efficiency of the pressure sensors.

Claims

1. A pressure sensor comprising:

a joint member (6) for securing a pressure sensor body to a fluid channel wall (5) for fluid; and a pressure-detecting element (7) mounted on the joint member (6), said pressure-detecting element being separately formed from said joint member,

characterized in that:

said pressure-detecting element (7) has a pressure sealing surface (10); and
said joint member (6) is provided with a sealing force application device (13, 14) for applying a sealing force between said pressure sealing surface (10) and said fluid channel wall (5).

2. The pressure sensor as claimed in Claim 1, wherein:
said pressure-detecting element (7) has a pressure detection portion, said pressure detection portion comprising a thin-film type strain gage (7e), which is provided on a metallic diaphragm (7a) of the pressure-detecting element (7) through an insulating film.

3. The pressure sensor as claimed in Claim 1, wherein:
said joint member (6) and said pressure-detecting element (7) are connected with each other so as to permit a relative movement to each other.

4. The pressure sensor as claimed in Claim 1, wherein:
said joint member (6) and said pressure-detecting element (7) are fixed to each other.

5. The pressure sensor as claimed in Claim 1, wherein:
said pressure-detecting element (7) has at least one part, which is formed through a forging method.

FIG. 1

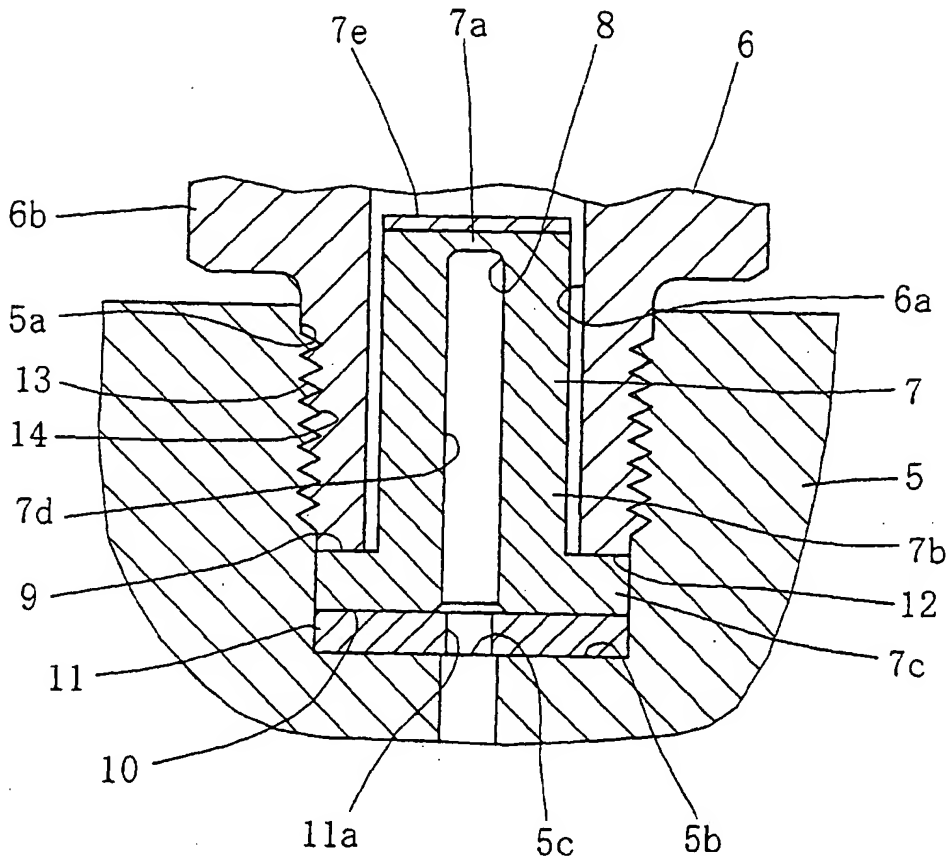


FIG. 2

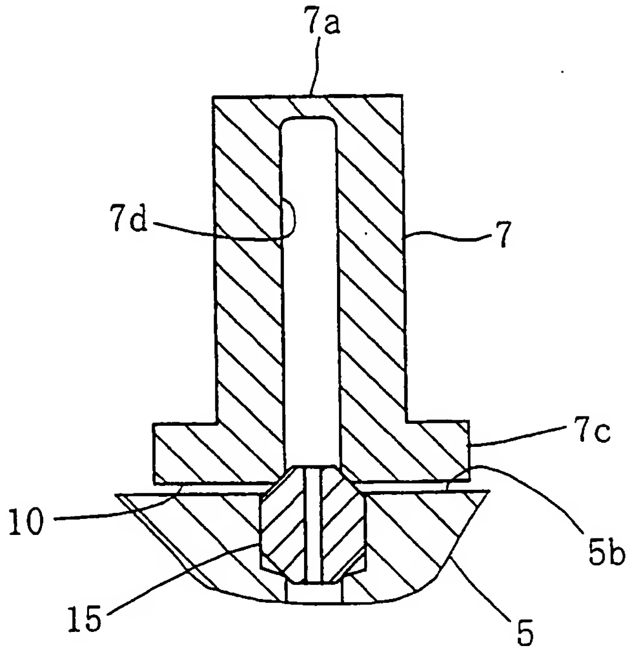


FIG. 3

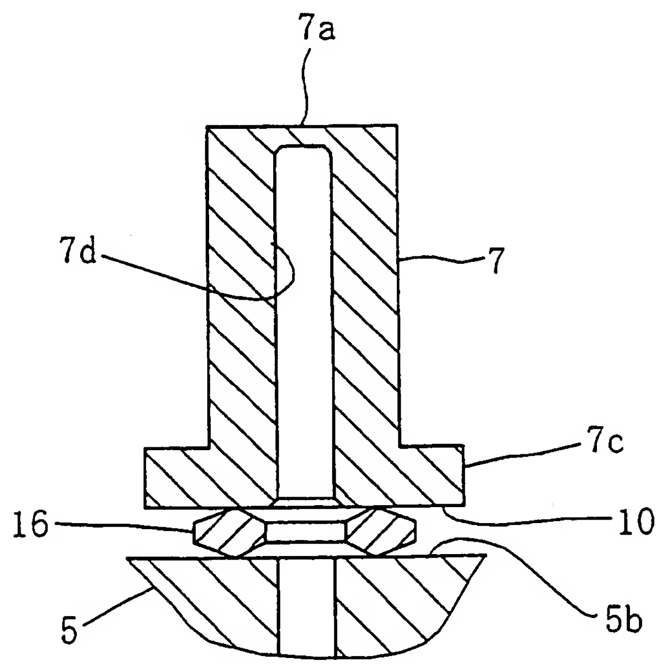


FIG. 4

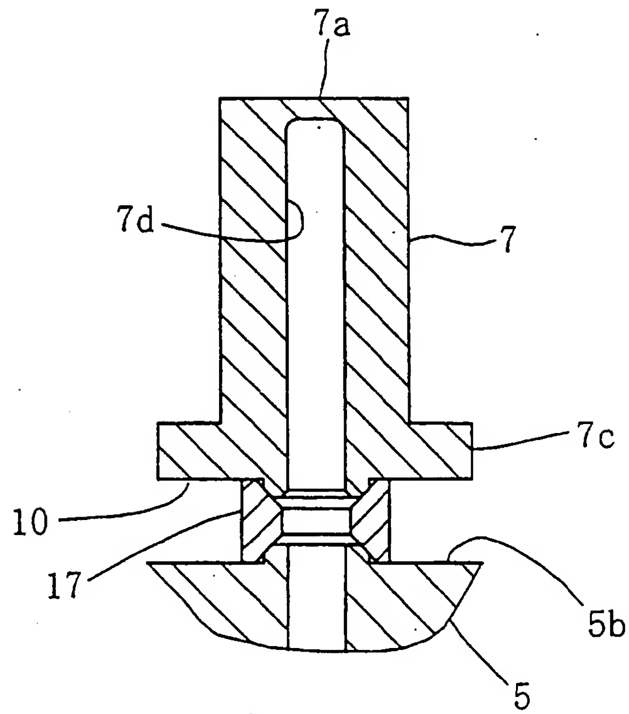


FIG. 5

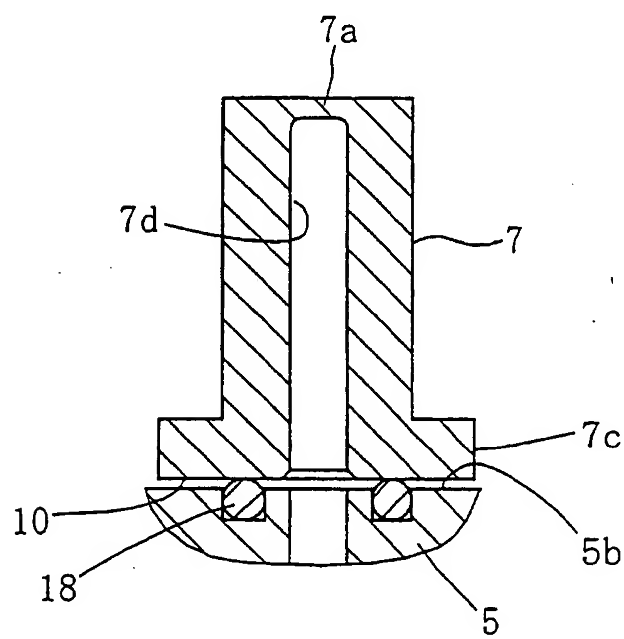


FIG. 6

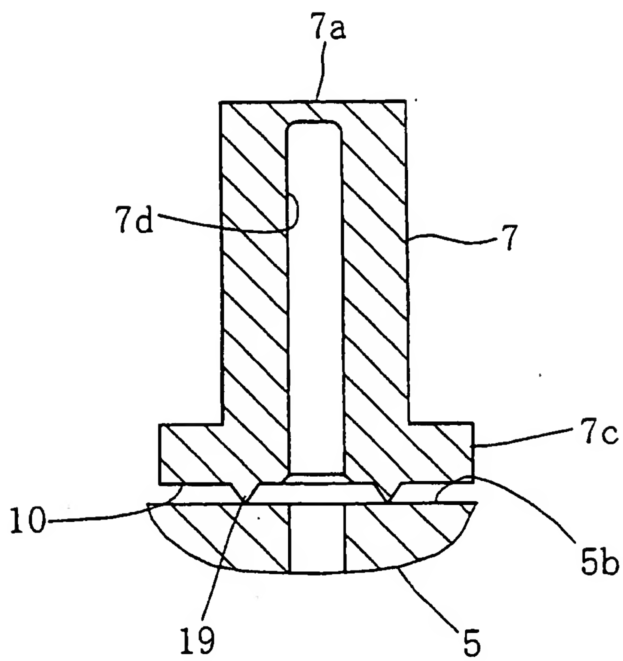


FIG. 7

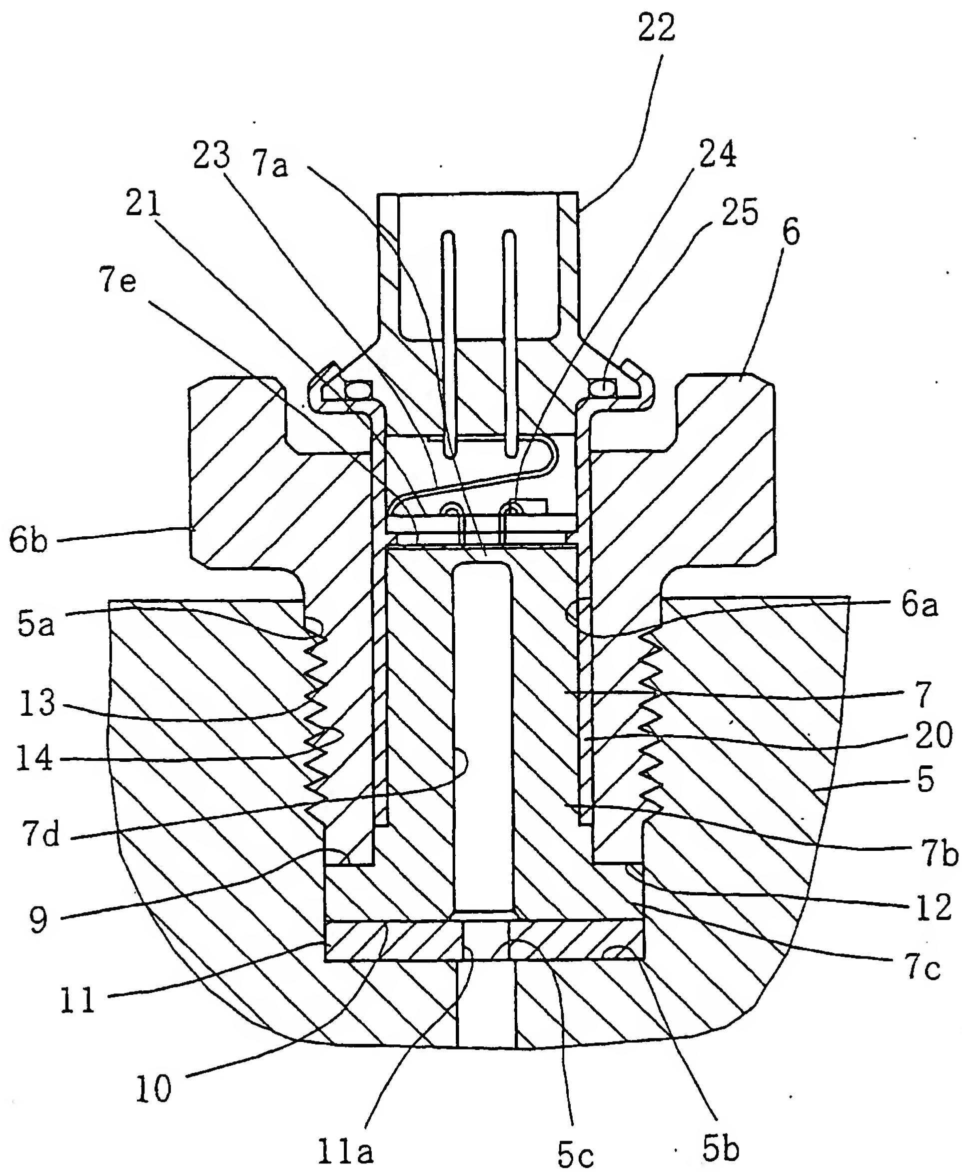


FIG. 8

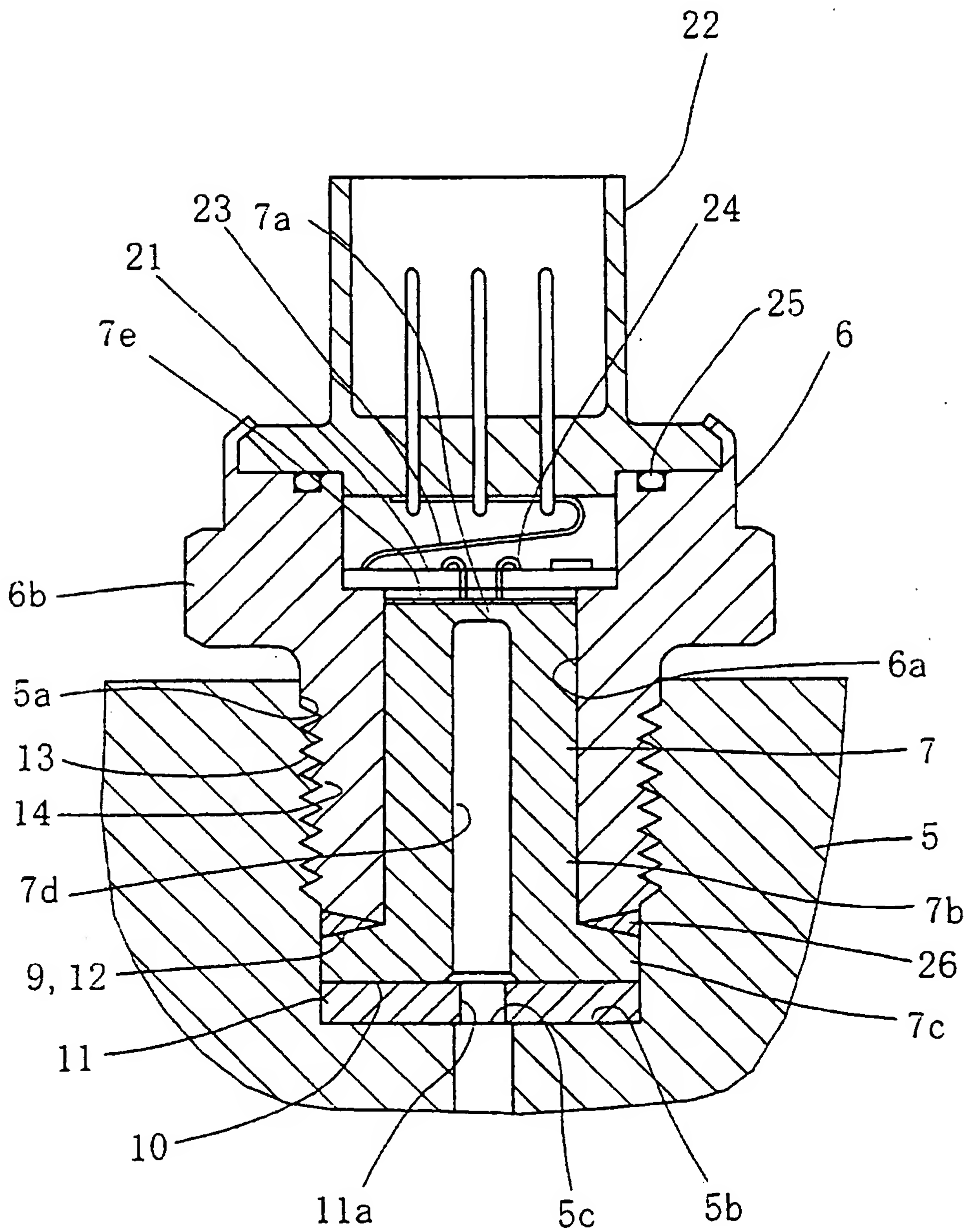


FIG. 9

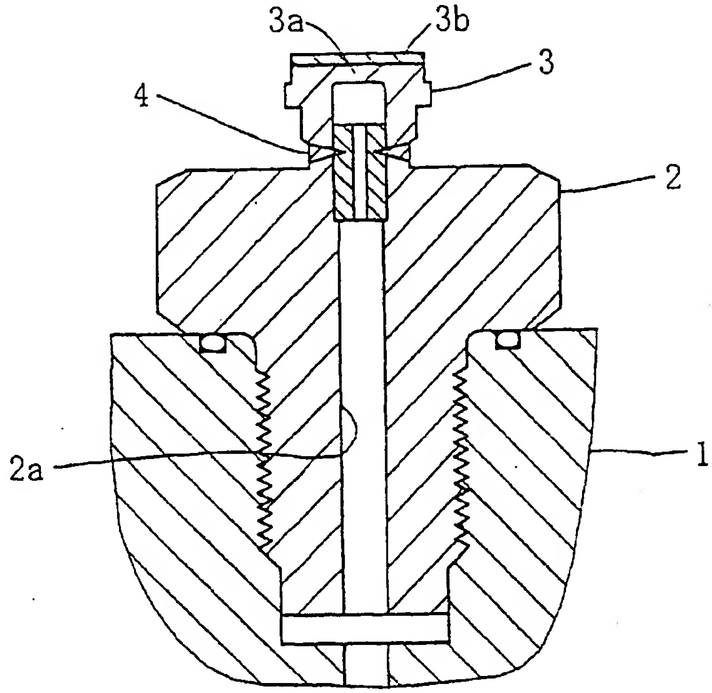
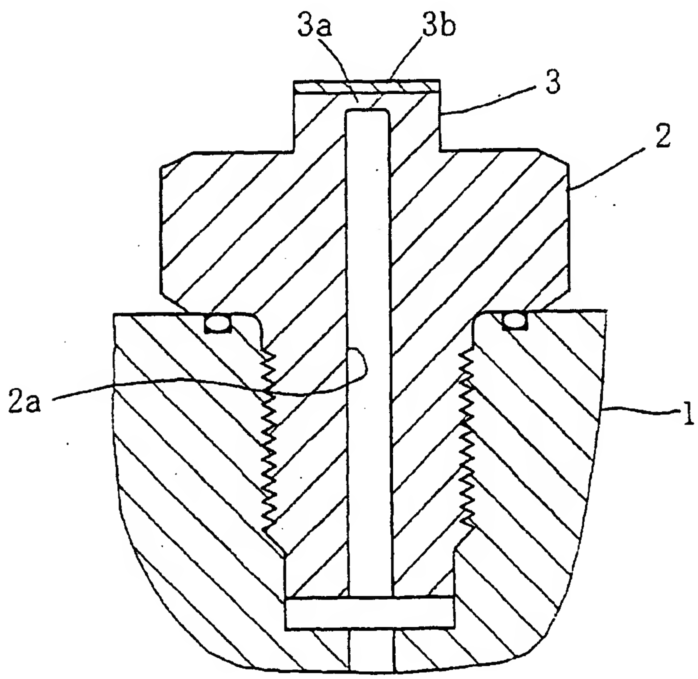


FIG. 10



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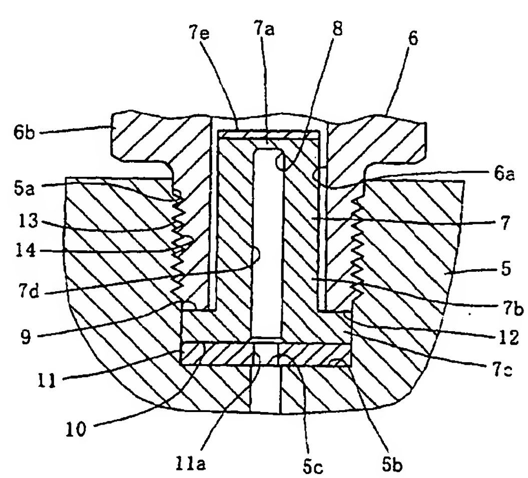
(54) Pressure sensor mounting

(57) A pressure sensor comprising a joint member (6) for securing a pressure sensor body to a fluid channel wall (5) for fluid; and a pressure-detecting element (7) mounted on the joint member (6). The pressure-detecting element is separately formed from the joint member. The pressure-detecting element (7) has a pressure sealing surface (10). The joint member (6) is provided with a sealing force application device (13, 14) for applying a sealing force between the pressure sealing surface (10) and the fluid channel wall (5).

FIG. 1



EP 1 146 326 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 30 3159

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 3 851 530 A (SYMONDS J ET AL) 3 December 1974 (1974-12-03) * claim 1; figures * -----	1-5	G01L19/00 G01L9/04 G01L9/00
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			G01L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	25 July 2002	Nobrega,R.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03 82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 01 30 3159

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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25-07-2002

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 3851530	A	03-12-1974	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

Patented May 25, 1954

2,679,411

UNITED STATES PATENT OFFICE

2,679,411

HIGH-PRESSURE TUBING COUPLING

Thomas G. Moore, Takoma Park, Md., assignor to American Instrument Company, Inc., Silver Spring, Md.

Application January 10, 1949, Serial No. 70,001

1 Claim. (Cl. 285—167)

1

This invention relates to couplings, and more particularly to a safety coupling for connecting tubing to valves, pressure vessels, and various high pressure devices.

A main object of the invention is to provide a novel and improved coupling for connecting high pressure tubing to valves, pressure vessels, and the like, said coupling eliminating the hazards of explosion of the fastening elements of the coupling by providing an escape path for leakage fluid, whereby said leakage fluid is not allowed to build up an excessive pressure inside the coupling.

A further object of the invention is to provide an improved safety coupling for making joints between tubing and high pressure valves or pressure vessels, said coupling being simple in construction and being protected against disruption by the building up of excessive internal fluid pressure therein due to leakage, whereby hazards to personnel in the vicinity of the coupling are substantially reduced and whereby failures of the coupling are avoided.

Further objects and advantages of the invention will become apparent from the following description and claim, and from the accompanying drawings, wherein:

Figure 1 is a vertical cross-sectional view taken axially through an assembled high pressure coupling constructed in accordance with the present invention.

Figure 2 is an elevational detail view, partly in cross-section, of a fastening nut employed in the high pressure coupling of Figure 1.

Figure 3 is an elevational detail view, partly in cross-section, of a sleeve member employed in the high pressure coupling of Figure 1.

Figure 4 is a fragmentary detail elevational view of the end of the high pressure tubing shown in the assembly of Figure 1.

High pressure tubing is connected to valves, fittings, pressure vessels, and the like, by means of union type couplings, as illustrated in Figure 1.

According to the prior art, the tubing 1 is prepared with a conical end 2 and a left hand screw thread 3. A sleeve 4 having similar left hand screw threads is screwed onto the tube, as shown. A nut 5 formed with a recess 6 to accommodate the sleeve 4 is screwed into the body 7 of the valve, fitting, pressure vessel, or the like, by means of right hand screw threads 8.

The nut 5 bears on the sleeve 4 to force the cone end 2 of the tube 1 into contact with a female cone 9 formed in the body 7.

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The sealing force between male cone 2 and female cone 9 is so great that the joint can be made pressure tight at pressures up to 100,000 pounds per square inch.

It so happens that the joint between cone 2 and cone 9 will sometimes leak, due to dirt between the engaging surfaces or imperfections in the seats. The operator usually attempts to stop the leak by exerting greater torque on the nut 5. This excess torque causes slight deformation of the screw threads and renders them pressure tight. Also, surface 10 of sleeve 4 and surface 11 of nut 5 are wrung together with such intimate contact as to create a pressure tight joint.

If the leak persists, fluid under pressure will continue to leak from the joint between cone 2 and cone 9 and fill space 6. As the fluid cannot escape through screw threads 8 or from the joint between surfaces 10 and 11, pressure builds up in space 6 until nut 5 bursts, in the manner of a pressure vessel subjected to excess pressure.

When nut 5 bursts, the joint may fly apart with explosive violence, so that the operator may be injured by pieces of metal or by fluid under high pressure.

Nut 5 is likely to fail in this manner when operating pressures in excess of 50,000 pounds per square inch are encountered.

In accordance with the present invention I employ a sleeve 4 which is so formed and arranged that pressure cannot build up inside of nut 5. Referring to Figures 1 and 3, it will be seen that notches 13 are formed in the top edge 10 of sleeve 4, these notches providing an escape path for fluid which leaks into space 6. The fluid which escapes enters space 14 and flows out into the atmosphere without bursting the nut 5.

Similar notches 13 are preferably also formed in the bottom edge of sleeve 4, as shown, so that the sleeve may be employed in inverted position.

By providing an escape path for fluid, as described above, I have been able to employ the nut and sleeve type of coupling above mentioned for pressures up to 100,000 pounds per square inch.

While a specific embodiment of an improved high pressure coupling has been disclosed in the foregoing description, it will be understood that various modifications within the spirit of the invention may occur to those skilled in the art. Therefore it is intended that no limitations be placed on the invention except as defined by the scope of the appended claim.

May 25, 1954 T. G. MOORE 2,679,411

HIGH-PRESSURE TUBING COUPLING

Filed Jan. 10, 1949

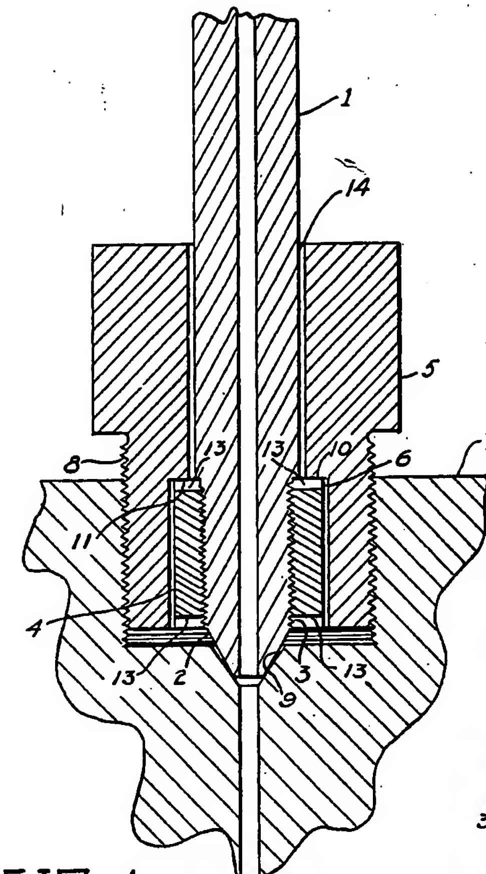

FIG. 1

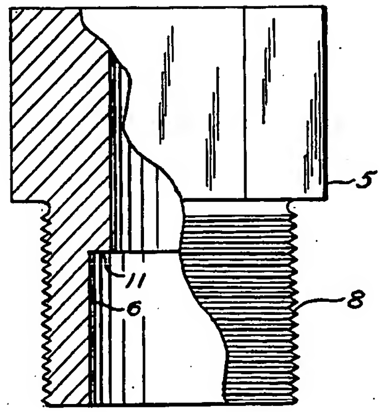

FIG. 2

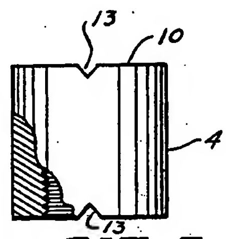

FIG. 3

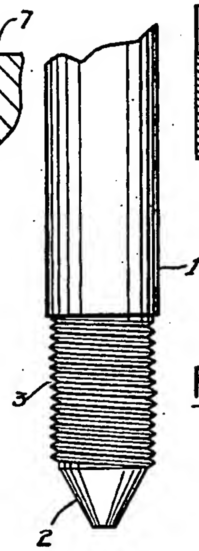

FIG. 4

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What is claimed is:

In a coupling of the character described, a tubular male member provided at its end with a sealing element, a collar element carried by said male member adjacent its end, and a nut element loosely surrounding said male member and defining clearance therewith, said nut element being formed with a bottom recess loosely receiving said collar element, the bottom recess of the nut element having a downwardly facing surface extending substantially from said male member normal thereto and arranged to engage the top surface of said collar element in face-to-face abutment therewith, whereby downward sealing force can be evenly exerted by the nut element on the male member, one of said surfaces being formed with a groove extending substantially from the internal side wall of the recess to the male member and defining a clearance channel for the escape of fluid from said recess inwardly to the male member and upwardly past the outer surface of the male member and out of the nut element.

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